Strategies for the Previously Operated Septum

Derek H. Liu, MD[a], Grant S. Hamilton III, MD[b], Brian J.F. Wong, MD, PhD[a,c,d,*]

KEYWORDS

• Septoplasty • Septal deviation • Rhinoplasty • Nasal obstruction

KEY POINTS

- Recurrent or persistent nasal obstruction after a routine septoplasty is a common and challenging complication that requires careful planning and proceeding with a revision operation.
- Precise identification of the underlying causes of obstruction requires both systematic evaluation of the septum and consideration of other potential sources, such as the internal nasal valve and inferior turbinates.
- Deviations occurring outside the standard chondrotomy, such as the dorsal or caudal L-strut, often require rhinoplasty techniques for adequate correction.

BACKGROUND

Nasal obstruction is one of the most common indications for evaluation by an otolaryngologist. The deviated nasal septum is the most prevalent contributor, affecting more than three-quarters of symptomatic patients.[1] As a result, septoplasty is amongst the most commonly performed operations for nasal obstruction.[2,3] Endonasal, or "closed," approaches are typically used for access, utilizing either a hemitransfixion (Cottle) or Killian incision. In this operation, the mucoperichondrium is elevated off the quadrangular cartilage, vomer, and perpendicular plate. An incision may be made through the septal cartilage, and a contralateral mucoperichondrial flap is elevated. Alternatively, in a Cottle approach, dissection proceeds across the caudal septum to the opposite side. With both mucosal flaps raised, obstructing cartilage and/or bone is generally resected. A chondrotomy is made such that an "L-strut," composed of dorsal and caudal components at least 10-mm to 15-mm wide, is preserved to provide structural support. This procedure, referred to as a submucous resection (SMR), can be approached either using nasal speculums and headlight illumination, or with sinus endoscopes.[4]

ETIOLOGY

Despite its widespread prevalence, the success rate of primary septoplasty ranges from 43% to 85%, depending on the outcome measure.[5] The causes of persistent nasal obstruction after septoplasty are complex. Oftentimes, there was unrecognized internal nasal valve narrowing or collapse, affecting as many as 82% of patients presenting with severe nasal obstruction despite septoplasty and inferior turbinate reduction.[5] In comparison, 46% had persistent inferior turbinate hypertrophy, and 52% had persistent septal deviation.[1] More rarely, over-resection of the septum can lead to development of a saddle nose, which

[a] Department of Otolaryngology – Head and Neck Surgery, University of California, Irvine, Orange, CA, USA; [b] Department of Otolaryngology – Head and Neck Surgery, Mayo Clinic, Rochester, MN, USA; [c] Department of Biomedical Engineering, University of California, Irvine, Irvine, CA, USA; [d] Beckman Laser Institute & Clinic, University of California, Irvine, Irvine, CA, USA
* Corresponding author. Beckman Laser Institue, 1002 Health Sciences Road, Irvine, CA 92697.
E-mail address: bjwong@hs.uci.edu

Facial Plast Surg Clin N Am ■ (2026) ■–■
https://doi.org/10.1016/j.fsc.2026.01.002
1064-7406/26/© 2026 Elsevier Inc. All rights are reserved, including those for text and data mining, AI training, and similar technologies.

Abbreviations

ESG extended spreader graft
SMR submucous resection
UCL upper lateral cartilage

causes middle vault collapse and internal nasal valve dysfunction.[6]

Common sources of persistent septal deviations include residual or recurrent deviations of the remaining L-strut, high septal deflections deep within the superior nasal vault "attic," or residual spurs that were incompletely resected during the primary surgery. Many patients undergoing revision septoplasty have multiple, concurrent sites of deviation.[5,7–9] These sources of residual deviation are often not addressed by the standard SMR technique and require more advanced rhinoplasty techniques. For example, caudal or dorsal deviations may have been inadequately addressed during the primary surgery. Alternatively, contractile forces associated with wound healing, combined with the weight of the nasal tip skin-soft tissue envelope, may cause flexure or torsional deformation despite preservation of an adequately wide and straight L-strut.[10]

Significant attention has been paid to the L-strut width, which surgeons have classically advocated to be 10 to 15 mm in width. However, studies have also suggested that thickness of the L-strut may contribute even more significantly to L-strut strength than width.[11,12] Even with preservation of adequate dorsal and caudal L-strut cartilage, loading across the nasal tip may lead to torsional deformation and either caudal or dorsal septal deformities. The shape of the chondrotomy may also affect the stability of the L-strut, with the standard sharp-cornered chondrotomy associated with higher tensile stress at these key points compared with a curved incision.[3] Curving the corners of the L-strut leads to a significant reduction in tensile stress, particularly at the junction of the dorsal and caudal septum (**Fig. 1**). After removing the central quadrangular cartilage, the stress will be concentrated at the junction of the dorsal and caudal struts causing it to deform and extend laterally, resulting in encroachment of the internal nasal valve. These concentrated stresses may be compounded when there is excess cartilage relative to the skin-soft tissue envelope, which creates increased tension and contractile forces.

Another less-recognized cause of deviation after a septoplasty is elevation of a unilateral flap. As noted by Goldman, the tensile stresses at the interface of the cartilage and the mucoperichondrium between the elevated and non-elevated sides are uneven, which can prevent correct alignment of the septum.[13,14] Traction from the unelevated mucoperichondrium often leads to recurrence of the deformity.

PRE-OPERATIVE EVALUATION

Classification of Septal Deviations

Many septal deviation classification systems exist, most of which describe deviations as C-shaped or S-shaped, either in the anteroposterior or cephalocaudal dimensions.[15] For example, Guyuron described 6 classes by including septal tilt and localized spurs.[16] Mladina classified septal deviations into 7 types, which was later modified by Rao.[17,18] However, other than Buyukertan, who divided the septum into 10 segments, most of these classification systems are limited in their ability to precisely localize areas of deformity.[19,20] Cottle also divided the internal nose into 5 areas, although some authors have criticized its limited clinical applicability.[21–23] Additionally, most of these systems do not adequately capture multiple concurrent deformities. Addressing persistent obstruction starts with the identification of the residual sites or causes of obstruction.

We have previously proposed a septoplasty deformity grading system (**Fig. 2**) that addresses both the anatomic localization and the grading of deformities at each location. The system identifies 7 anatomical regions that have been shown to be significantly deviated and assigns both a laterality and a severity on a 4 point Likert scale from 0 to 3. The advantage of this system is to provide a reliable method to characterize the location and severity of septal deformities, and importantly, provides a framework for surgical planning. Conceptually, deviations on the central quadrangular cartilage are typically treated adequately during a standard SMR, while the encircling structures present more significant challenges and may require rhinoplasty techniques (**Fig. 3**).

Grafting Material

Management of persistent septal deviations often requires placement of cartilage grafts to stabilize the L-strut. Spreader grafts and septal battens are such examples. In addition to precise identification of sources of septal deviation, preoperative planning should also include an assessment of the existing cartilage available and a corresponding plan for obtaining adequate cartilage for possible grafting requirements. If the primary operation was performed by a different surgeon, obtaining operative reports may provide key information regarding the extent of the cartilaginous resection. Additionally, some surgeons

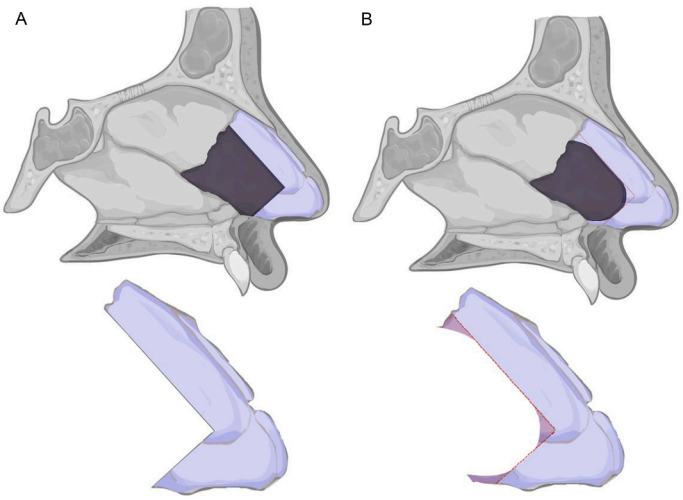

Fig. 1. (*A*) Standard chondrotomy that creates a sharp corner at the intersection of the dorsal and caudal incisions. (*B*) Curving the corners of the L-strut decreases the tensile stress compared with a standard chondrotomy (*red line*, *bottom right*), as described by Menapace and colleagues.

routinely replace unused straight remnant cartilage after SMR, either in anticipation of potential revision procedures or to provide additional support to the central defect.

In most cases, an SMR has been performed without replacement of any cartilage, and the nose is depleted. Without sufficient septal cartilage, the patient should be counseled regarding the need to harvest conchal or costal cartilage. While conchal cartilage may have minimal donor-site morbidity, its thickness, concave shape and relatively limited supply make it less suitable for revising a persistently deviated septum. Instead, costal cartilage provides ample thin and strong grafts, particularly when meticulously carved using a concentric technique to reduce warping.[24] Irradiated homograft costal cartilage is a reasonable alternative in a patient with significantly calcified costal cartilage but may be prone to resorption.[25] Alternatively, a bone graft may be harvested from the ethmoid perpendicular plate and provides strong structural support, particularly in bracing the caudal and dorsal L-strut components.

TREATMENT STRATEGIES

Mucosal Flaps

Elevation of mucosal flaps in a secondary septoplasty is more challenging than in a primary for a few reasons. Foremost, there is often an absence of cartilage in the central septum, resulting in both mucosal flaps being scarred together. Additionally, the flaps may be atrophic and thin, further complicating their separation. Fortunately, the remaining septal L strut can be useful to maintain one's orientation during the dissection. Begin by elevating the mucoperichondrium from one side of the caudal septal strut. Follow the cartilage inferiorly to the maxillary crest. Next, proceed along the dorsal strut. Once these 2 tunnels are created, it is straightforward to connect them with careful blunt dissection. Once the bony septum is encountered, it will be necessary to restart a subperiosteal plane of dissection. In general, only elevate these flaps if access is needed to a more posterior deviation.

Spurs

Cartilaginous spurs often occur at the junction of the quadrangular cartilage and anterior bony septum (maxillary and vomerine bone). The sphenoid process, a posterior extension of the quadrangular cartilage, consistently overlies the bony spur, suggesting an underlying interaction at the bony-cartilaginous junction, leading to formation of spurs at this location.[26] An adequate SMR likely addresses most spurs at this location. However, spurs on the inferior septum and bony maxillary crest are observed in as many as 13% of patients undergoing revision septoplasty.[27] Bony spurs occurring more posteriorly on the vomer may be "missed" during initial septal surgery, particularly when there are significant anterior deviations.[28] Residual spurs that were inadequately treated during the primary surgery can be resected during the revision surgery.

Perpendicular Plate

When resecting the osseous septum, pulling or twisting motions may lead to fractures radiating to the cribriform plate and skull base. Becker serrated double-action B scissors may reduce the risk of trauma by gripping the bone more securely while cutting, reducing motion along the cut line that may occur with non-serrated scissors. Still, conservative treatment of this region may

	1	2	3
Spur	Mild, may not require treatment	Intermediate	Touches turbinate
Caudal Deviation	Within columellar footprint	Slightly deviates columella	Resides in nares
Dorsal Curvature (Mid Vault- C Shape)	Non-surgical	Requires Spreader Graft	Adjacent/ touches the ULC
Dorsal Deviation off Angle	Non-surgical	Requires Spreader Graft	Adjacent/ touches the ULC
PP-Vomer- QC Junction	Non-surgical	Obstructive	Touches turbinate
PSA	Within columellar footprint	Slightly deviates columella	Resides in nares
ASA	Slight deviation of tip	Moderate deviation of tip	Severe deviation of tip

Fig. 2. Graphical depiction of septal deformity severity grading scale. (Gu, J.T. et al., (2019), Validation of a septoplasty deformity grading system for the evaluation of nasal obstruction. The Laryngoscope, 129: 586-593. https://doi.org/10.1002/lary.27365.)

lead to persistent, high septal deviations. Given the concern for iatrogenic CSF leak, surgeons have more recently advocated for the use of piezoelectric-powered ultrasonic instruments. These instruments generate piezoelectric oscillations of ultrasonic frequency, which can be utilized to atraumatically cut or contour bone while also leaving soft tissues untouched. Piezoelectric instruments have been used throughout various components of rhinoplasty surgery, including for the safe treatment of high septal deviations. Sections of the perpendicular plate should be removed without any twisting motion, reducing the risk of skull base injury.[29,30] Likewise, with an ultrasonic device (eg, CUSA or Sonopet), the perpendicular plate can be contoured, thinned, and readily displaced toward the midline.

Caudal Deviations

Caudal septal deviations may be challenging to correct, particularly during a standard endonasal

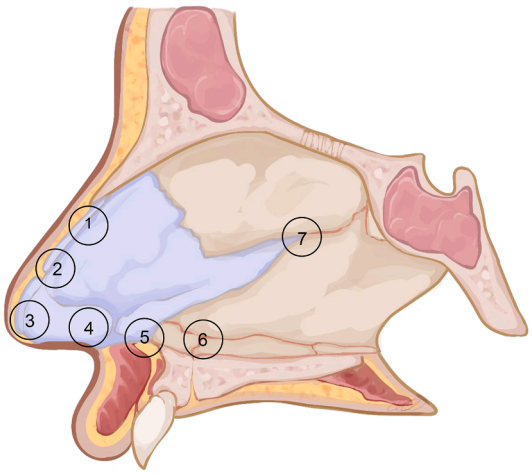

Fig. 3. Anatomical locations of residual septal deformities not adequately treated by a submucus resection (SMR): (1) dorsal mid-vault, (2) dorsal septum, (3) anterior septal angle, (4) caudal septum, (5) posterior septal angle, (6) maxillary crest, and (7) perpendicular plate-vomer-quadrangular cartilage junction.

SMR. To address a caudally deviated septum, various techniques have been described. Metzenbaum described a "swinging door" technique, where the septum is released from the maxillary crest, and repositioned and fixed to the contralateral aspect of the nasal spine.[31] While this can address the ventral aspect of the caudal septum, the curvature of the caudal septum itself is unchanged. Scoring the cartilage is sometimes performed to break the "memory" of the cartilage, but it is less predictable and may weaken the septum, leading to flexure and subsequent nasal deformity.[10,28]

The tongue-in-groove technique was described by Kridel as a method to improve the appearance of the nasal tip and reduce columellar show while also correcting caudal septal deviation.[32] The medial crura, which are anatomically connected to each other and to the caudal septum by loose fibrous tissue, are advanced cephalo-posteriorly and suture fixated onto the caudal septum. By creating a space between the medial crura to accommodate the caudal septum, a hanging columella may be reduced. At the same time, the medial crura provide some modest support to correct a deviated caudal septum. Also, if a space between the medial crura is not created, the caudal septum will be more prone to settling in its previously deviated location.

Several grafting techniques have also been described for the correction of caudal septal deviation. Metzinger described ethmoid bone sandwich grafting, which harvests 2 ethmoid bone battens and secures them on either side of the caudal strut.[33] Other studies of bony batten grafting, which fixates septal bone to one side of the caudal septum, emphasize the advantages of high rigidity without adding much thickness compared with cartilage grafts.[34,35] However, there is a possibility of bone resorption and recurrence of the deviation, although this has not yet been observed in the existing studies. Others advocate for the use of cartilaginous batten grafting, which can also be used to lengthen the caudal septum if needed.[36]

Posterior Septal Angle

Addressing caudal septal deviations also requires assessment of the posterior septal angle and its position relative to the anterior nasal spine. Misalignment of the PSA-ANS geometry may cause deviation or flexure of the columella and tip, which cannot be addressed by grafting alone. In severe cases, the PSA may be located within the nares and completely separate from the ANS. Disarticulation allows for both repositioning in the midline, as well as trimming of any excess caudal L-strut that would lead to a height mismatch with the skin-soft tissue envelope. In other cases, the PSA and ANS are aligned in the midline, but the articulation is unstable, which also warrants surgical fixation, as a lack of stability may lead to flexure or torsion of the caudal L-strut when a load is applied.

The PSA-ANS can be stabilized by either placing sutures through the periosteum surrounding the ANS or by creating a drill hole in the ANS and passing figure-of-eight sutures. Choosing to suture to the periosteum versus creating a drill hole should be made by assessing the geometry of the ANS. An ANS with an inferior surface oriented horizontally provides more stability than an inferior surface oriented vertically, in which case the suture is more prone to tearing the periosteum and slipping (**Fig. 4**).[37] Importantly, prior to any repositioning, the position of the ANS should also be assessed as the spine is not always midline. Without recognizing this, securing the PSA to a lateralized spine assuredly leads to a persistent caudal deviation. In such cases, the PSA may be positioned lateral to the native spine position.

Dorsal Deviations

The dorsal cartilaginous septum defines the middle third of the nose. One group has described correction of a dorsal deviation using a modified mattress suture technique, but suture techniques are generally thought to be inadequate for the most severe deviations.[38,39] Spreader grafts, first described by Sheen in the 1980s, may be placed between the dorsal quadrangular cartilage and the upper lateral

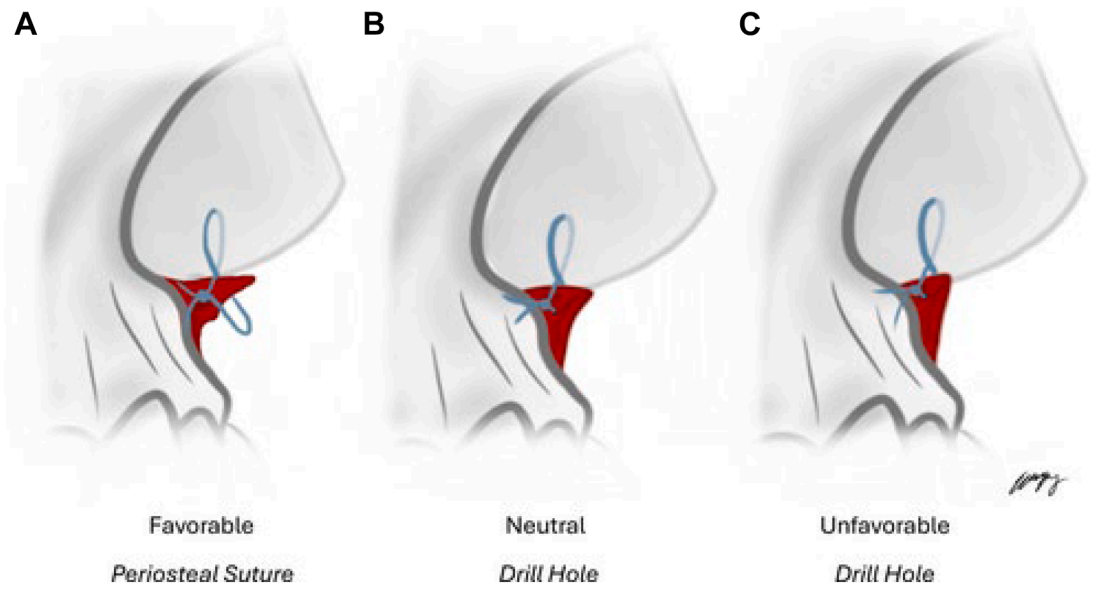

Fig. 4. Variations of anterior nasal spine (ANS) geometry and their suitable fixation techniques: (*A*) A favorable ANS is suitable for passing sutures to the periosteum. (*B*) ANS with an inferior surface oriented more vertically is better addressed using a drill hole, (*C*) ANS with a vertical inferior surface necessitates a drill hole. (Hong, E.M et al., (2025), Repositioning the Posterior Septal Angle in Rhinoplasty: Methods and Outcomes. The Laryngoscope, 135: 1975-1982. https://doi.org/10.1002/lary.31973.)

cartilages (ULCs) to straighten and reinforce the dorsal L-strut. Initially, spreader grafts were popularized as a method for preventing nasal valve collapse by broadening the nasal valve.[40,41] They have also been used for correction of inverted V deformities by providing additional support at the junction of the dorsal septum and UCL while also reconstructing dorsal aesthetic lines.[42,43] In rhinoplasty, spreaders can be extended dorsally into the gap between the perpendicular plate and nasal bones (after medial osteotomy) when needed to further stabilize the L-strut.

Alternatively, extended spreader grafts (ESG) may be useful for treating dorsal deviations during rhinoplasty when tip modification is also needed. By extending beyond the antero-caudal septum region, ESGs reinforce the dorsal septum while also controlling nasal tip and length.[44] A caudal septal extension graft or columellar strut can be fixated by ESGs on either side, providing additional long-term tip and caudal septum stability.[40,45] When used for tip support, some place ESGs bilaterally to avoid deviation of the tip to the side of a unilateral ESG, although placing bilateral grafts can cause excessive widening of the mid-vault and may require more extensive cartilage harvesting.[45]

Preservation Rhinoplasty

First introduced by Goodale in 1899, dorsal preservation rhinoplasty has recently surged in interest.[46] Preservation rhinoplasty techniques treat the nasal dorsum as an osseocartilaginous joint, mobilizing the entire bony pyramid as a unit to reshape the dorsum without separating the UCL from the dorsal L-strut.[47] The bony nasal pyramid is repositioned to achieve dorsal height change, axis shift, and more. This is commonly combined with a modification of the septum, which allows for lowering of the dorsum. Numerous septal modification techniques exist, ranging from high, intermediate, or low septal strips, to the Tetris concept and subdorsal Z-flap.[46,48,49] Many of these techniques create sharp corners, which theoretically also concentrates tensile stress at these junctions, although, to date, there is no evidence of delayed deviations.[3] Moreover, many consider dorsal preservation techniques to be challenging to apply to severely crooked or deviated noses, although some have described a “Pisa Tower concept” in which asymmetric bony wedge excisions are combined with a swinging door septoplasty to correct severe deviations.[48,50,51] Others advocate for a “hybrid” approach in which the deviated septum is treated with more aggressive structural rhinoplasty techniques.[52] Ultimately, there is significant heterogeneity in septal modification techniques in preservation rhinoplasty, and relatively fewer long-term studies as a result of the recency of adoption. Further studies are necessary to understand the long-term stability of different septal modification techniques in this context.

Saddle Nose Deformity

Loss of septal integrity, particularly of the dorsum, may lead to a saddle nose deformity, defined as a visible depression on lateral view and loss of height of the nose. While the structural deficiency typically involves the cartilage, the bony dorsum may also be involved in severe deformities. This weakness may be caused by autoimmune medical conditions such as granulomatosis with polyangiitis or relapsing polychondritis. Excessive application of vasoconstrictors, such as illicit cocaine use, may also cause cartilage loss and saddling. More commonly, saddle nose is caused by prior nasal trauma or prior septal surgery.[53] Specifically, saddling may result from excessive resection of septal cartilage leading to an inadequate L-strut, disruption of the keystone area, or dislocation of the caudal septum from the anterior nasal spine. The incidence of saddle nose after septoplasty is generally considered low. Some studies report significant changes in cosmetic appearance occurring in 0.4% to 3.4% of patients after septoplasty, which includes not only saddle nose but also other cosmetic deformities such as supratip depressions.[54]

Multiple systems classify the degree of saddling and corresponding treatment algorithms.[53,55–58] Most include a mild group defined by overresection of the dorsum, leading to a relative depression or "pseudosaddle" appearance while septal integrity is preserved. These deformities are primarily cosmetic in nature and may be treated with simple camouflaging methods such as augmentation with crushed or diced cartilage. For these minor concavities with no structural concerns, an endonasal approach may be sufficient.[55,59]

More advanced deformities are associated with loss of nasal length, cartilaginous vault collapse, and loss of tip support. These cases typically require major septal reconstruction, which can be accomplished through a variety of techniques to address the patient's specific deformity. The L-strut may be reconstructed using either unilateral or bilateral ESGs combined with a caudal septal extension graft or a columellar strut graft. These spreader grafts are designed to be "tall" and rise above the existing dorsal profile to correct a mild saddle nose. Once the structural integrity of the dorsum has been established, additional solid or diced cartilage dorsal grafts can be placed for aesthetic contouring.[55,59,60] Alternatively, extracorporeal septoplasty (discussed below) may be useful in cases of both saddle deformity and severe deviation.

The most severe cases may also have components of bony vault disruption, limiting the support for reconstruction. Reconstruction of the rigid framework may necessitate osseocartilaginous rib grafts or split calvarial bone grafts.[60,61] Wire fixation or plating may be necessary to secure the grafts. Often, the internal lining of the nose is also contracted and difficult to release from the underlying structures. This lining may be insufficient to cover the reconstructed nasal framework, with some using forehead flaps or pericranial flaps to provide mucosal coverage.[59,60] Extensive mobilization of the skin-soft tissue envelope is also required to achieve sufficient external coverage of the underlying framework.

Extracorporeal Septoplasty

In cases of severe or multilevel deviations, some surgeons advocate for extracorporeal septoplasty as a technique to reconstruct the L-strut when more conservative techniques are inadequate.[25,62] First described by King and Ashley in 1952, and more extensively by Gubisch in 1995, complete removal and replacement of the cartilaginous septum is performed and a neoseptum is fashioned from the straight portions of the native septal cartilage and reattached via 2 points of fixation.[63,64] First, the posterior septal angle is reattached to the maxillary crest. Second, the neoseptum is reattached to the caudal end of the nasal bones, or the keystone area, which is technically demanding with risk of notching or dorsal saddling.[65] This technique was later modified to preserve a 1.5-cm dorsal septum remnant to which the reconstructed septum is sutured. The posterior septal angle still required reattachment to the maxillary crest. This modified technique, often referred to as anterior septal reconstruction, achieved significant improvements in nasal obstruction while reducing the technical challenges and the potential aesthetic complications associated with rebuilding keystone area.[65–67]

Authors have since described a variety of additional modifications to the technique. When the deviation primarily affects the caudal septum, a larger segment of the dorsal septum may be preserved.[68] If the native septum is too distorted or insufficient for reconstruction of the neoseptum, other autologous options include auricular or costal cartilage, with costal cartilage typically chosen for its straighter shape, abundance and potentially thinner profile. Some advocate the use of a rigid scaffold, such a bony perpendicular plate or polydioxanone plate, to provide additional stabilization to the implanted cartilage.[69,70] Many studies describe fixating the posterior septal angle to the anterior nasal spine using figure-of-eight suture either through the ANS periosteum or a hole

drilled in the ANS, but others use splinting grafts to improve caudal stability.[25,65,71] A systematic review of extracorporeal septoplasty found broad variation in techniques as well as significant heterogeneity in outcome measures and study methodology. They concluded that the technique is likely effective but additional study with standardized methods is needed.[72]

SUMMARY

Primary septoplasty is an effective and widespread procedure for the treatment of nasal obstruction. However, a significant percentage of patients are dissatisfied with their post-operative outcomes, most often due to persistent nasal obstruction. Secondary surgery is often more challenging and is accompanied by increased patient expectations to achieve a satisfactory outcome. Successful secondary surgery requires a precise and thorough analysis of the root causes, which are often multifactorial and include unrecognized pathologies other than the septum. Addressing these etiologies often requires a diverse surgical toolkit that includes complex rhinoplasty techniques.

CLINICS CARE POINTS

- Curving the corners of the chondrotomy reduces the tensile forces, particularly at the junction of the dorsal and caudal L-strut, which may help prevent recurrence of septal deviation and the need for revision surgeries.
- Preoperative evaluation of the septum should identify all locations and severities of persistent deviation. Many patients also have internal nasal valve dysfunction, which was not recognized initially.
- If significant cartilage has been removed during the initial surgery, costal cartilage and ethmoid bone provide straight and rigid sources of grafting material.
- Extracorporeal septoplasty is an advanced but effective technique that can readily correct a severely deformed nose when grafting and other techniques are insufficient.

DISCLOSURES

The authors have nothing to disclose.

REFERENCES

1. Clark DW, Del Signore AG, Raithatha R, et al. Nasal airway obstruction: prevalence and anatomic contributors. Ear Nose Throat J 2018;97(6):173–6.
2. Manoukian PD, Wyatt JR, Leopold DA, et al. Recent trends in utilization of procedures in otolaryngology-head and neck surgery. Laryngoscope 1997;107(4):472–7.
3. Menapace DC, Carlson KD, Dragomir-Daescu D, et al. Finite element analysis of the septal cartilage L-Strut. Facial Plast Surg Aesthet Med 2021;23(2):90–7.
4. Shah J, Roxbury CR, Sindwani R. Techniques in septoplasty: traditional versus endoscopic approaches. Otolaryngol Clin North Am.W.B. Saunders 2018;51(5):909–17.
5. Becker SS, Dobratz EJ, Stowell N, et al. Revision septoplasty: review of sources of persistent nasal obstruction. Am J Rhinol 2008;22(4):440–4.
6. Chambers KJ, Horstkotte KA, Shanley K, et al. Evaluation of improvement in nasal obstruction following nasal valve correction in patients with a history of failed septoplasty. JAMA Facial Plast Surg 2015;17(5):347–50.
7. Derin S, Sahan M, Deveer M, et al. The causes of persistent and recurrent nasal obstruction after primary septoplasty. J Craniofac Surg 2016;27(4):828–30.
8. Jin HR, Kim DW, Jung HJ. Common sites, etiology, and solutions of persistent septal deviation in revision septoplasty. Clin Exp Otorhinolaryngol 2018;11(4):288–92.
9. Lee DJ, Jo H, Kwon HN, et al. Causes and management of persistent septal deviation after septoplasty. Sci Rep 2022;12(1). https://doi.org/10.1038/s41598-022-23772-y.
10. Luu NN, Friedman O. Septal deviation after septorhinoplasty: causes and surgical management. Facial Plast Surg 2020;36(1):072–7.
11. Mowlavi A, Masouem S, Kalkanis J, et al. Septal cartilage defined: implications for nasal dynamics and rhinoplasty. Plast Reconstr Surg 2006;117(7):2171–4.
12. Paul N, Messinger K, Liu YF, et al. A model to estimate L-strut strength with an emphasis on thickness. JAMA Facial Plast Surg 2016;18(4):269–76.
13. GOLDMAN IB. New technique in surgery of the deviated nasal septum. Arch Otolaryngol Head Neck Surg 1956;64(3):183–9.
14. Lawson W, Westreich R. Correction of caudal deflections of the nasal septum with a modified Goldman septoplasty technique: how we do it. Ear Nose Throat J 2007;86(10):617–20.
15. Teixeira J, Certal V, Chang ET, et al. Nasal septal deviations: a systematic review of classification systems. Plast Surg Int 2016;2016:1–8.
16. Guyuron B, Uzzo CD, Scull H. A practical classification of septonasal deviation and an effective guide to septal surgery. Plast Reconstr Surg 1999;104(7):2202–9 [discussion: 2210–2].
17. Mladina R, Čujić E, Šubarić M, et al. Nasal septal deformities in ear, nose, and throat patients. An

international study. American Journal of Otolaryngology - Head and Neck Medicine and Surgery 2008;29(2):75–82.
18. Rao JJ, Kumar ECV, Babu KR, et al. Classification of nasal septal deviations-Relation to sinonasal pathology. Indian J Otolaryngol Head Neck Surg 2005; 57(3):199–201.
19. Lin JK, Wheatley FC, Handwerker J, et al. Analyzing nasal septal deviations to develop a new classification system: a computed tomography study using MATLAB and OsiriX. JAMA Facial Plast Surg 2014; 16(3):183–7.
20. Buyukertan M, Keklikoglu N, Kokten G. A morphometric consideration of nasal septal deviations by people with paranasal complaints; a computed tomography study. Rhinology 2003;41(1):21–4. Available at: http://www.ncbi.nlm.nih.gov/pubmed/12677736.
21. Huizing EH. Incorrect terminology in nasal anatomy and surgery, suggestions for improvement. Rhinology 2003;41(3):129–33.
22. Garaycochea O, Alobid I. On the Cottle areas and the proposal for a new classification of septal areas. Rhinology.International Rhinologic Society 2023; 61(2):190–2.
23. Huizing E, de Groot J. Functional reconstructive nasal surgery. Thieme; 2003.
24. Kim DW, Shah AR, Toriumi DM. Concentric and eccentric carved costal cartilage. Arch Facial Plast Surg 2006;8(1):42–6.
25. Wu PS, Hamilton GS. Extracorporeal septoplasty: external and endonasal techniques. Facial Plast Surg 2016;32(1):22–8.
26. Saedi B, Rashan AR, Lipan M, et al. Consistent ipsilateral development of the posterior extension of the quadrangular cartilage and bony spur formation in nasal septal deviation. Otolaryngology-Head Neck Surg (Tokyo) 2015;152(3):444–8.
27. Gillman GS, Egloff AM, Rivera-Serrano CM. Revision septoplasty: A prospective disease-specific outcome study. In: Laryngoscope. Vol 124. John Wiley and Sons Inc.; 2014:1290-1295. doi:10.1002/lary.24356.
28. Sillers MJ, Cox AJ, Kulbersh B. Revision septoplasty. Otolaryngol Clin North Am 2009;42(2): 261–78.
29. Tremp M, Schneider J, Raghu RBN, et al. A systematic analysis of the nasal septum in crooked noses and suggested treatment algorithm according to preservation rhinoplasty (PR) principles. Aesthetic Plast Surg.Springer 2023;47(4):1499–507.
30. Gerbault O, Daniel RK, Kosins AM. The role of piezoelectric instrumentation in rhinoplasty surgery. Aesthetic Surg J 2015;36(1):21–34.
31. Metzenbaum M. Replacement of the lower end of the dislocated septal cartilage versus submucous resection of the dislocated end of the septal cartilage. Arch Otolaryngol Head Neck Surg 1929;9(3): 282–96.
32. Kridel RWH, Scott BA, Foda HMT. The tongue-in-groove technique in septorhinoplasty. Arch Facial Plast Surg 1999;1(4):246–56.
33. Metzinger SE, Boyce RG, Rigby PL, et al. Ethmoid bone sandwich grafting for caudal septal defects. Arch Otolaryngol Head Neck Surg 1994;120(10): 1121–5.
34. Chung YS, Seol JH, Choi JM, et al. How to resolve the caudal septal deviation?: clinical outcomes after septoplasty with bony batten grafting. Laryngoscope 2014;124(8):1771–6.
35. Kim DY, Nam SH, Alharethy SE, et al. Surgical outcomes of bony batten grafting to correct caudal septal deviation in septoplasty. JAMA Facial Plast Surg 2017;19(6):470–5.
36. Kim JH, Kim DY, Jang YJ. Outcomes after endonasal septoplasty using caudal septal batten grafting. Am J Rhinol Allergy 2011;25(4). https://doi.org/10.2500/ajra.2011.25.3648.
37. Hong EM, Vasudev M, Nguyen C, et al. Repositioning the posterior septal angle in rhinoplasty: methods and outcomes. Laryngoscope 2024; 135:1975–82.
38. Shin J, Cho J, Hong SD, et al. Internal nasal valve modification via correction of high dorsal deviation using a modified mattress suture technique. J Clin Med 2022;11(19). https://doi.org/10.3390/jcm11195888.
39. Kang JM, Nam ME, Dhong HJ, et al. Modified mattress suturing technique for correcting the septal high dorsal deviation around the keystone area. Am J Rhinol Allergy 2012;26(3):227–32.
40. Jeon YJ, Lee TH, Joo YH, et al. Aesthetic and functional outcomes of combined use of extended spreader graft and septal extension graft. Life 2025;15(4). https://doi.org/10.3390/life15040546.
41. Sheen JH. Spreader graft: a method of reconstructing the roof of the middle nasal vault following rhinoplasty. Plast Reconstr Surg 1984;73(2):230–9.
42. De Pochat VD, Alonso N, Mendes RRS, et al. Nasal patency after open rhinoplasty with spreader grafts. J Plast Reconstr Aesthetic Surg 2012; 65(6):732–8.
43. Teymoortash A, Fasunla JA, Sazgar AA. The value of spreader grafts in rhinoplasty: a critical review. Eur Arch Otorhinolaryngol 2012;269(5):1411–6.
44. Palacín JM, Bravo FG, Zeky R, et al. Controlling nasal length with extended spreader grafts: a reliable technique in primary rhinoplasty. Aesthetic Plast Surg 2007;31(6):645–50.
45. Bahman G, Xia TY. Evolution and versatility of the bilateral extended spreader graft: a review and an update to the tongue-and-groove technique. Aesthetic Plast Surg 2023;47(5):2023–8.
46. Patel PN, Most SP. Overview of dorsal preservation rhinoplasty. Facial Plast Surg Clin N Am 2023; 31(1):1–11.

47. Goksel A, Cason RW, Tran KN, et al. The blocking points: the keys to consistent success in preservation rhinoplasty. Plast Reconstr Surg 2024;153(5):922e–31e.
48. Finocchi V, Vellone V. Managing the severe septal deviation using dorsal preservation. Facial Plast Surg Clin N Am 2023;31(1):107–17.
49. Neves JC, Tagle DA, Dewes W, et al. A segmental approach in dorsal preservation rhinoplasty. Facial Plast Surg Clin N Am 2021;29(1):85–99.
50. Finocchi V, Vellone V, Ramieri V, et al. Pisa tower concept: a new paradigm in crooked nose treatment. Plast Reconstr Surg 2021;148(1):66–70.
51. East C. Preservation rhinoplasty and the crooked nose. Facial Plast Surg Clin N Am 2021;29(1):123–30.
52. Tremp M, Schneider J, Raghu RBN, et al. A systematic analysis of the nasal septum in crooked noses and suggested treatment algorithm according to preservation rhinoplasty (PR) principles. Aesthetic Plast Surg 2023;47(4):1499–507.
53. Daniel RK, Brenner KA. Saddle nose deformity: a new classification and treatment. Facial Plast Surg Clin N Am 2006;14(4):301–12.
54. Lee JJ, Hong SD, Dhong HJ, et al. Risk factors for intraoperative saddle nose deformity in septoplasty patients. Eur Arch Otorhinolaryngol 2019;276(7):1981–6.
55. Chen YY, Jang YJ. Refinements in saddle nose reconstruction. Facial Plast Surg 2018;34(4):363–72.
56. Tardy ME, Schwartz M, Parras G. Saddle nose deformity: autogenous graft repair. Facial Plast Surg 1989;6(2):121–34.
57. Young K, Rowe-Jones J. Current approaches to septal saddle nose reconstruction using autografts. Curr Opin Otolaryngol Head Neck Surg 2011;19(4):276–82.
58. Cakmak O, Emre IE, Ozkurt FE. Identifying septal support reconstructions for saddle nose deformity: the cakmak algorithm. JAMA Facial Plast Surg 2015;17(6):433–9.
59. Hamilton GS. Correction of the saddle nose deformity. Facial Plast Surg 2020;36(1):7–17.
60. Daniel RK. Rhinoplasty: septal saddle nose deformity and composite reconstruction. Plast Reconstr Surg 2007;119(3):1029–43.
61. Shipchandler TZ, Chung BJ, Alam DS. Saddle nose deformity reconstruction with a split calvarial bone l-shaped strut. 2002. Available at: www.liebertpub.com.
62. Toriumi DM. Subtotal septal reconstruction: an update. Facial Plast Surg 2013;29(6):492–501.
63. King ED, Ashley FL. The correction of the internally and externally deviated nose. Plast Reconstr Surg 1952;10(2). Available at: https://journals.lww.com/plasreconsurg/fulltext/1952/08000/the_correction_of_the_internally_and_externally.8.aspx.
64. Gubisch W. The extracorporeal septum plasty: a technique to correct difficult nasal deformities. Plast Reconstr Surg 1995;95(4):672–82.
65. Wilson MA, Mobley SR. Extracorporeal Septoplasty Complications and New Techniques. Vol 13. 2011. Available at: www.liebertpub.com.
66. Most SP. Anterior Septal Reconstruction Outcomes After a Modified Extracorporeal Septoplasty Technique. Vol 8.; 2006.
67. Toriumi DM. How I do it head and neck and plastic surgery: a targeted problem and its solution: subtotal reconstruction of the nasal septum: a preliminary report. Laryngoscope 1994;104(7):906–13.
68. Asher SA, Kakodkar AS, Toriumi DM. Long-term outcomes of subtotal septal reconstruction in rhinoplasty. JAMA Facial Plast Surg 2018;20(1):50–6.
69. Serna EM, Tapia FC. Extracorporeal septoplasty: variations of the technique. Facial Plast Surg 2014;30(2):194–204.
70. Rimmer J, Saleh H. Use of polydioxanone plate in septal reconstruction. Facial Plast Surg 2013;29(6):464–72.
71. Jang YJ, Kwon M. Modified extracorporeal septoplasty technique in rhinoplasty for severely deviated noses. Ann Otol Rhinol Laryngol 2010;119(5):331–5.
72. Spataro EA, Saltychev M, Kandathil CK, et al. Outcomes of extracorporeal septoplasty and its modifications in treatment of severe l-strut septal deviation: a systematic review and meta-analysis. JAMA Facial Plast Surg 2019;21(6):542–50.